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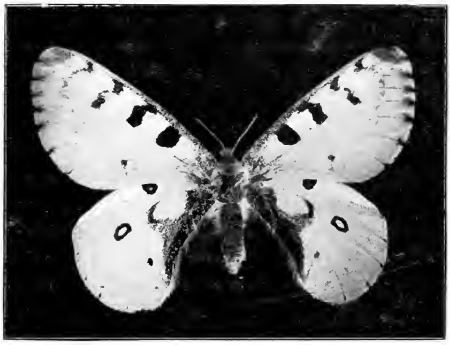

SECOND ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

BY

R. A. COOLEY

BOZEMAN, MONTANA
DECEMBER, 1904

Montana Agricultural College
Experiment Station

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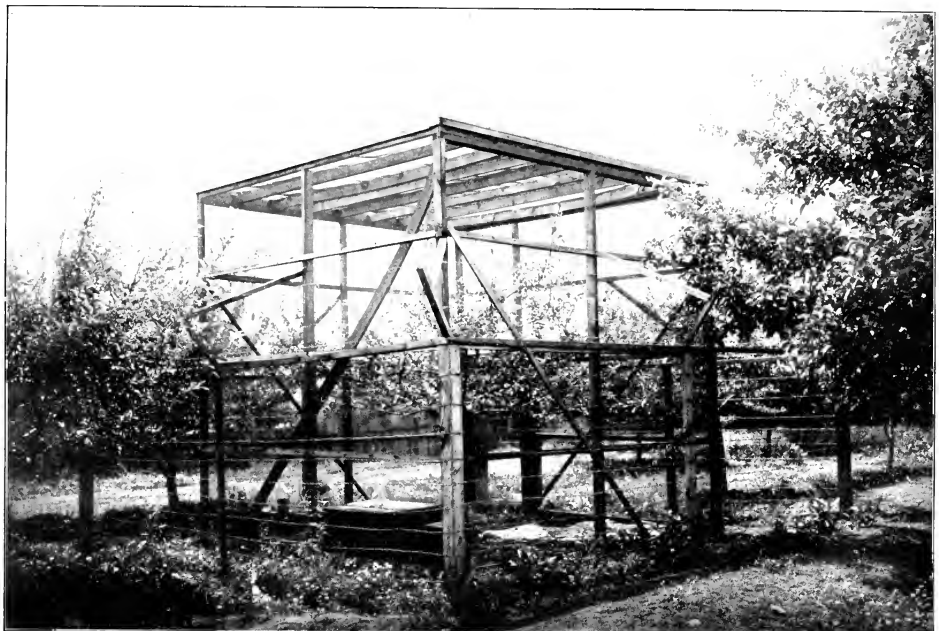

Cage at Missoula used for the study of the life-histories of the codling moth and the bud moth. The cage is 12X12 feet on the ground and 12 feet high.

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THE ELM MEALY-BUG.

Phenacoccus dearnessi King.

While searching for cocoons of the codling moth under scales of bark of apple trees in Missoula in January, 1902, numerous cottony masses were found secreted under the scales and not visible except when the scales are picked off. These cottony masses contained the eggs and adults of a mealy-bug which I have referred to *Phenacoccus dearnessi* King. Specimens were sent to Prof. T. D. A. Cockerell, the American authority on these insects, and he replied that it appeared to be this species and on comparing it with the descriptions his conclusion was found to be correct.

On April 30th in the same vicinity in Missoula, numerous mealy-bugs, which later were found to be the same species, were found closely packed on elm buds which at that date were greatly swollen and about to open. See Fig. 1, 1. During the remainder of the

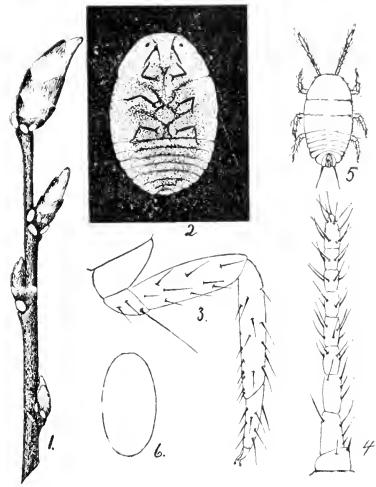


Fig. 1. **The Elm Mealy Bug:** 1, Mealy bugs at bases of buds of elm in spring of the year, natural size; 2, adult female from below, enlarged; 3, leg of female, enlarged; 4, antenna of female, enlarged; 5, newly hatched larva, enlarged; 6, egg, enlarged.

season of 1902 and in 1903 the species was commonly seen both on the apple and the elm at Missoula.

On making inquiry I learned from Mr. C. F. Dallman, proprietor of the Missoula nursery that this insect has at times been so abundant on the limbs and trunks of elms as to cause the leaves to wither. From the foregoing it appears that while the insect was originally found on the apple at Missoula it is more particularly a pest of the elm and that on that desirable shade tree it is capable of becoming a serious pest. So far as the notes in this office show, we have, beside this mealy-bug, only one serious pest of elms in Montana. This is the aphis which lives on the leaves causing them to curl and become deformed.

HISTORY OF THE SPECIES.

Phenacoccus dearnessi was originally described by Mr. Geo. B. King. Mr. John Dearness collected the original specimens from an old hawthorne tree near London, Ontario. The species has not been heard of since Mr. King's mention of it in Volume 33 of the Canadian Entomologist until this writing.

A RELATED SPECIES.

This mealy-bug is a member of the family of bugs scientifically known as *Coccidae*. To this family belong the true scale insects—soft scales, cottony cushion scale, the cochineal insect, and the lac insect. Altogether they form a very large and important group there being upward of one-thousand five hundred species known to science. Another species in the same genus as the one that is the subject of this paper, has been injurious on maples in the eastern part of the United States. This species (*P. acericola* King) has about three broods during the year and does its damage by sucking the juices out of the leaves. The cottony masses on the under side of the leaves are conspicuous objects and where the insects become abundant they cause the leaves to become yellowish and sickly or drop off prematurely. The winter is passed by the young nymphs which secrete themselves in the crevices of the bark and there remain dormant. In the spring becoming active again they crawl to the leaves.

HABITS OF THE ELM MEALY-BUG.

We have learned but little of the life-history of the species found at Missoula but it is probable that it is similar to that of the maple-inhabiting species. However, it is plain from our observations that at least a part of the insects remain on the trunk of the apple throughout the summer. In fact, though we were often in the orchard in Missoula where this insect occurred in 1902, frequently running across clusters of the insects under the scales of bark, we did not in a single instance find any of them on the leaves. Occasionally we found the partly grown female insects crawling about the limbs and twigs but never attached and feeding except on the trunk. Under the scales of bark the insects were invariably found under the newly formed scales where the bark was of a light color and thin.

The habit of the females in the spring of the year to cluster about the buds of the elm as shown in the accompanying figure, is a prominent one though we did not detect any injury done in this way. As the female insect feeds and grows she produces a very light and soft cottony mass about herself which is pure white. On coming to maturity the insect deposits her eggs in this cottony mass. When the young hatch from the eggs they work their way to the surface and go off to find a suitable place to secure food.

CONFUSED WITH THE WOOLLY APHIS.

It is a well known habit of the areal form of the woolly aphis to settle on newly made scars on the trunks of apple trees taking their nourishment through the tender tissues to be found there. This mealy-bug was found affecting apple trees in the same manner. So similar are the cottony masses of the two insects that the writer was able to be sure of the identity of the mealy-bug only by breaking apart the flocculent matter and examining the bodies themselves.

DESCRIPTIONS.

The male and female mealy-bug are very unlike in appearance. The male is very delicate and has long transparent wings, long legs, and long antennae. Its size is much less than that of the female which is about 1/8 of an inch long. With all secretions removed

the body of the female is yellowish in color. The legs and antennae are short and there are no wings. The female walks very slowly.

A technical description of the species is not given here but may be found on page 180, of Vol. XXXIII, Canadian Entomologist, 1901.

REMEDIES.

This pest may be controlled by the use of soap or kerosene washes applied to the trunks of the trees during the winter season. Its complete destruction will be facilitated by scraping off the loose outer bark before applying the wash. Kerosene emulsion and soap washes have been discussed in previous publications of this department of the Experiment Station.

THE STRAWBERRY CROWN-GIRDLER.

Otiorhynchus ovatus Linn.

The strawberry crown girdler was brought to the writer's attention as a pest in Montana in the summer of 1899 and since that time has been the subject of much interest in this office. The economic and biological features have been closely studied, but while we now make a report, it is not because we have learned all that we might on these subjects. More work might be done on the evasive problems connected with the life-history and methods of controlling the insect, but having reached a point where recommendations suggest themselves, it seems desirable to publish what information we have secured. We shall at the same time review the work of previous writers.

During the summer of 1902 observations of considerable value were made on the natural history of the species both in the field and in the laboratory, and again in 1903 facts of some value were secured. During the past summer (1904) Mr. Burle J. Jones, a graduate of the Montana Agricultural College and a thorough student of entomology, was stationed by this office at Missoula for the purpose of collecting insects and observing the habits of certain pests. He was informed of the status of our knowledge of this insect and instructed to closely observe its habits in order to verify our previous notes and if possible to secure new facts. Because of the fact that we were unable to have Mr. Jones in the field early in

the season and to keep him there until the close of the season, we did not have an opportunity to determine the number of broods of the beetle nor the stage in which most of the insects pass the winter. Mr. Jones made the observations on the effects of spraying with, and dipping in, arsenate of lead, and very carefully studied the habits of the insects during the three and a half months of his stay at Missoula.

GEOGRAPHICAL DISTRIBUTION.

The strawberry crown girdler is an introduced species, having come to this continent in all probability from Europe. It is known to occur in Europe and Siberia. In the United States it has been found from the Atlantic coast west to the state of Washington. The most southerly points at which it has been recorded are Alleghany, Pa., and Santa Fe, New Mexico. Both of these points are just within the southern boundary of the transitional life-zone and it is probable that this beetle finds its southern limit at about the line between the transitional and upper austral life-zones.

From the list of places given below, where the beetle has been recorded, it will be seen that though of foreign origin, this insect has become widely and generally distributed. Being entirely without wings it is dependent upon possible agencies for transportation except over such short distances as it can cover by walking. More will be said about the means of distribution in a later paragraph.

The following is a list of the records of the distribution of the strawberry crown-girdler.

Massachusetts, 1852, Henshaw, Cambridge, Mass., 1865, Henshaw, Cambridge, Mass., 1874, Henshaw, Wyoming, Mass., 1874, Henshaw, Alleghany, Pa., 1875, Wickham, Detroit, Mich., 1878, Wickham, Hanover, N. H., 1880, Henshaw, Buffalo, N. Y., 1882, Wickham, New York, 1884, Lintner, "Southern Michigan," about 1882 or 1883, Weed, Ottawa, Canada, 1884, Harrington, Iowa City, Iowa, "not later than 1886," Wickham, Nova Scotia, 1886, Chicago, Ill., 1889Wayne Co., Ohio, 1892, Quebec, Canada, 1892, Indiana, 1892, New Jersey, Laramie, Wyoming, 1893, Wickham, Santa Fe, New Mexico, 1894, Wickham, Minnesota, 1895, Lugger, Missoula, 1897, Wilcox, Bozeman, Montana, 1899, Cooley, Helena, Montana, 1904, Cooley, Lake Washington, Wash., 1904, Melander (in Lit.)

COMMON NAMES.

This insect has been known in Mont. under the name of straw-berry-weevil, but since there are a number of other weevils that prey upon the strawberry, it would be advisable to use the more specific name first adopted by Prof. Weed, viz.: "The Strawberry Crown Girdler." In a reference in Insect Life (Vol. V, page 46) it is stated that in some localities the insect is known as the "graveyard bug." Professor Wickham, writing in Societas Entomologica (IX, page 131, 1894), states that Dr. Hamilton writing to him from Alleghany, Pa., stated: "I took this beetle in a cemetery here in 1875 and it was then apparently abundant. A couple of years afterwards it was excessively so in the same cemetery but now (1894) much less common than formerly." It may be that the beetle contracted the name of "graveyard bug" from its occurrence in the cemeteries of Alleghany as here quoted, but the literature does not make this point clear. There can be no reason why the insect should occur more abundantly in graveyards than elsewhere. Dr. Lugger in his short account of the beetle in Bulletin 66 of the Minnesota Experiment Station (1899) uses the common name, "The Pitchy-Legged Otiorhynchus." This name is obviously less desirable than "The Strawberry Crown Girdler."

FOOD PLANTS.

The following is a list of the plants on which this beetle feeds as shown by the literature of the species: borage (Cook), muskmellon (Webster), strawberry (Weed), currant (Mrs. Wickham), roots of blue grass (Webster), apple (?) (Lugger). The writer has found the larvae feeding on the roots of *Potentilla glandulosa*, a plant not distantly related to the strawberry, and has found the beetles hiding in abundance in the stools of this plant. The species was also taken feeding in the adult stage on the foliage of raspberry. Mr. Burle Jones found the roots of the plant commonly known as the "big root" or "balsam root" (*Balsamorhiza sagatata*) to be commonly attacked. He found fully one hundred weevils about one plant of this species and saw abundant signs of their attacks in other plants of this kind. Mrs. Williams of Missoula reports having found the larvae in great abundance on the roots of timothy grass.

As affecting the methods of controlling the ravages of this pest a knowledge of the food plants it is of great importance. More will be said on the subject under the head of remedies.

Only scattered observations on the feeding habits have been made as recorded above, but various writers have suggested that it is probable that the species feeds on a large variety of plants. Our observations bear out this belief. The food plants above recorded are widely scattered through the vegetable kingdom and it would not be surprising to find in a complete list, if such a list could be obtained, a very large number of widely differing plants.

Further observations on the feeding habits of this beetle in different parts of the United States are very desirable and might prove to be of great value.

INJURIOUSNESS.

In only two localities in this state has this pest become noticeably destructive, so far as we are informed. These two places are in Missoula Co., one being on the farm of Mr. Chas. Williams in the Rattlesnake Valley north of Missoula, and the other at the place of Mr. England west of the city. At Mr. England's place the beetles were very injurious about five years ago and drove him out of the business. He gave up attempting to grow strawberries for a period of four years, and then Mrs. England in the spring of 1904 set out a new bed not far from the old patch. So far as the experience of 1904 shows, no beetles are on the place. An explanation of this present freedom from the pest offers itself and is discussed under the head of remedies.

At the Williams place the beetles have prevented the profitable growing of strawberries for about eight or ten years. Great credit is due to these people for the persistence with which they have tried to overcome the pest. They have studied its habits both out of doors and in cages in the house and are remarkably familiar with its haunts and ways. They have moved their strawberry beds from one place to another all over their large and beautiful ranch and have invariably confronted the pest in each new spot. They have tried every means of control within their reach and have showed much ingenuity in their campaign but always at the time when the berries should be growing and coming to maturity, the vines gradually

weakened, because of the grubs at the roots, and they harvested very poor crops. The beetle has shown itself capable of wiping out the strawberry industry in the territory in which it operates. Up to this time we have been powerless to check its ravages.

Fortunately it spreads very slowly or else is closely confined to certain soil conditions. It has been a matter of much interest to us that on the farm adjoining that of Mr. Williams, just across the road and an irrigating ditch, strawberries have been grown very successfully. On one occasion I entered this field and found very luxurious foliage and saw the pickers harvesting a full crop of berries, while at the Williams place the crop was destroyed. After five years' experience with the insect we feel warranted in saying that it is probable that it is quite definitely confined in restricted localities and that excessive injury will result only when it is attempted to grow strawberries in these localities. In driving up the Bitter Root valley in the summer of 1902, I stopped by the road and collected insects. It developed that I was in the midst of a colony of this beetle. Masses of their dead bodies were to be found under pieces of bark on the ground. So far as I was able to learn no one has ever grown strawberries within several miles of this spot. The limits of this colony were not far off and beyond the limits no beetles were found. The fact that the species is gregarious in habits may in part but does not fully explain this marked tendency to live in limited areas. Further, it may be said that the presence of the beetle in a strawberry field in small numbers is not necessarily an indication that it will increase and become injurious. Though we have found the beetle in garden patches of strawberries in the city of Missoula we have never had a complaint from that city.

It is not a usual practice to continue to grow strawberries on one piece of ground year after year, and though a few specimens may be brought into a bed it is not probable that they will multiply with sufficient rapidity to become seriously injurious before the bed is abandoned. We believe that serious injury will be done only where strawberry beds are planted on fields where the beetles are already present in abundance. Literature shows no record of extensive injuries from this insect though its possibilities as a pest have been mentioned.

INJURIES TO PLANTS OTHER THAN THE STRAWBERRY.

It should be borne in mind that this beetle, being a very general feeder, may develop into a pest of various other plants. As we have mentioned under our discussion of food plants the larvae are said to feed voraciously on the roots of timothy grass. We may therefore expect it to be very injurious to crops of timothy that are planted in territory which it has invaded. There is nothing to assure us that it will not seriously injure various other crops.

NATURE OF ATTACK.

The adult beetles feed on the foliage of the strawberry and the larvae feed on the roots. In an old bed one or more years of age, the injury done to the foliage does not appear to be serious but on newly set plants in the spring or early summer, the beetles come in such numbers, eating the foliage and boring holes in the stems, as to destroy the bed before it gets a fair start. The experience of Mr. Williams has been that during the first summer when the plants were small and just getting started, here and there a plant would be killed. The next summer more would die and in the third summer, at the time fruit is growing, many plants would die owing to the large number of grubs at the roots. At the time the full crop should be expected the bed may be so invaded that not more than one plant in ten to twenty of those that were set out is left.

The beetles eat irregular patches out of the leaves as shown in plate II, fig. 2. This is a newly set plant photographed in the field. It is not uncommon to find from fifteen to thirty beetles hiding about a single young plant.

The larvae feed on the roots and kill the plants outright. A plant that is dead or nearly dead from this cause has many of its larger roots eaten off and is more easily removed from the earth than a healthy one. The younger larvae appear to feed on the fine rootlets some distance away from the crown of the plant, and as they grow older they work their way up the roots, many of them eventually reaching the crown or dense masses of roots just beneath the crown. I have never found a larva of this species really imbedded in the crown. They seem to prefer the more exterior parts just where the roots arise. Where they feed, a powdery brown substance, their castings, is to be seen. They also feed from the surface of the lower part of the crown more or less completely girdling the plant.

DESCRIPTIONS AND NATURAL HISTORY.

The general appearance of the adult beetle is well shown in the accompanying photographs, (see Plate I, figs. 1 and 2). These photographs are greatly enlarged but the beetle is also shown in natural size above and to the right of figure 1. When first emerged the beetles are light brown in color but they soon take on a permanent brownish black. The antennae are elbowed and are slightly enlarged at the very tip. The shell of the beetle is very hard.

Most beetles have a pair of wings folded beneath the hard horny wingcovers that overlie the abdomen or posterior part of the body, but in the case of the beetle in question no wings are present and the wing-covers are grown together in such a way that they could not be raised as in flight if the wings were present. The beetle therefore is as incapable of flight as a toad and for locomotion is dependent on walking or on outside agencies.

The adults are nocturnal in habits and gregarious. When disturbed they draw in their legs and play 'possum.

On examining the earth around strawberry plants affected with the adult beetles one finds small open holes that lead into the earth toward the roots. Carefully following these holes with a straw or the point of a knife blade the beetles may be found often in considerable numbers. These holes often follow the stems of leaves of plants that are newly set, being often just under and parallel with the stems. Other holes follow down under small clods of soil or other objects. Other beetles may be found under partly covered leaves and many may be found scattered through the soil about the roots. Among old plants they often crawl down into the crown where the new and old leaf-stems arise. In all such places they spend the day, coming out to feed during the night.

It appears that the beetles are more or less dependent upon food in order that they may develop ova. Our investigations have shown mainly that the beetles crawl about in the soil for the purpose of scattering their eggs. On our potted plants used for studying the beetles we found some eggs on the surface of the soil and a few even on the under surface of the leaves, but we believe that the normal place for egg deposition is in the soil. The soil in the pots was harder than is natural for out-of-door conditions and some of the

leaves were close to the earth. Many of the eggs in the pot experiment were found to be in the burrows and in the little cavities used by the beetles as retreats from the light. This habit of the beetle of scattering the eggs among the roots is perhaps nature's method of making sure that the very small weak larvae shall not fail to secure food, for it is very doubtful if the newly hatched young could make their way through the soil to the roots.

The habit of congregating in large numbers in darkened places is a marked one with this beetle and large numbers have often been found in houses under carpets and in similar places. Mrs. Williams' house was invaded by them and this peculiarity has been more often mentioned in literature than any other.

The gregarious habit is also shown when the beetles go into hibernation, for in the spring of the year under clods of earth, under stones, boards, etc. the beetles may be found in great abundance.

THE EGG STAGE.

The eggs of this beetle are very minute objects measuring only about .25 mm. long. The general shape and appearance are well shown at figure 4, plate I. When first laid the eggs are milky white but a little later they take on a pale brownish color.

We can closely judge of the duration of the egg stage from the following experiment. On May 31st, 1902 I brought living beetles from Missoula to Bozeman and on June 2nd ten beetles each were put on five strawberry plants in pots at the Experiment Station. On June 7th a few eggs were found. The eggs became more and more abundant and on the 21st there were many eggs to be found. The soil was not examined again until June 27th when a few young larvae were to be found. It thus appears that about twenty days or a little less are required for the eggs to hatch.

On June 27th the eggs were very abundant and it was roughly estimated that there were 200 eggs in one can. It was impossible to accurately count them. It will be remembered that ten beetles were placed on each plant and if one-half of these were males, the five females laid at the rate of forty eggs apiece. In making the examination, so much of the soil was removed from the roots of the plants that the plant which had already been weakened by the attacks of the beetles could not be kept alive longer; otherwise it is probable that more eggs would have been deposited.

THE LARVA.

The newly hatched larva resembles the older larva in shape and color but is much smaller, being almost microscopic in size. They feed on the fine rootlets and in a soft soil are perfectly at home, getting about slowly but with ease.

The older larva is a conspicuous object against a back ground of dark soil being itself almost white in color with a yellowsh head. See figure 6, plate I and figure 1, plate II.

We have nothing to indicate to us definitely the duration of the larval stage.

THE PUPA.

When full-fed and ready to pupate, the larva constructs an oblong cell in the soil and casting its skin becomes a pupa. See plate I, figure 5. In this cell the helpless pupa remains until the adult stage is reached.

The pupa is almost pure white, very soft and delicate, and shows distinctly the various parts which in adult life will be known as legs, antennae, beak, wings, etc. It is noticeable that the wing-sacs are separate along the line of the back, while in transforming to the adult stage they become fused forming one piece.

NUMBER OF BROODS AND HIBERNATION.

We can state definitely that the winter is passed both in the adult stage and as larvae. It may be also that some individuals pass the winter as pupae. As early as August the beetles begin to show a tendency to come together to go into hibernation quarters and yet in the fall and spring larvae may be found in the soil. The different stages so everlap each other that one can find eggs, larvae, pupae and adults all at the same time and this condition leads to much confusion in an attempt to determine the number of broods, We can give but little evidence as to the number though we hold the opinion that there is but one brood each year.

MEANS BY WHICH THE CROWN GIRDLER SPREADS.

It is a remarkable fact that though this insect possesses no wings and cannot fly, it is capable of widely distributing itself as is shown by the records of its occurrence. It is a slow walker, practically speaking, and is dependent upon outside means for its distribution. Very likely it has been distributed to some extent on strawberry plants sent for planting new fields. Its desire to avoid light would naturally lead it to retreat not only into houses, as has been recorded, but also into barns and other buildings as well as boxes, farm machinery, and any other objects whatsoever that offer desirable places of retreat. In any such objects that become articles of commerce or are removed from one place to another for any purpose, such as household goods, etc. carried by persons moving from one place to another, the beetles are liable to be taken into a new locality, and once in the new locality, being adapted to a large number of wild-growing and cultivated plants, they stand a fair chance of becoming established.

NATURAL ENEMIES.

We have observed no parasitic enemies of this beetle and Professor Weed bred none though he confined many of the insects for the purpose. Mrs. Williams reported to me that the domestic fowls followed the plough in the spring ravenously eating the early stages, which because of their white color, were conspicious objects. Mr. Weed reported that he found the predaceous larvae of *Carabid* or ground beetles in the earth around the roots of strawberries that were attacked by the girdler larvae.

REMEDIES.

The two general methods of restraining this pest that suggest themselves are the use of a poisonous spray and the use of such cultural practices as interrupt the life cycle of the beetle.

Mrs. Williams informed me that she had made a thorough test of the use of Paris green as a means of poisoning the adults on the foliage and had not been able to kill them. Knowing the general characteristics of the beetles we were not surprised at the results secured in the test and decided not to make any further tests with Paris green.

EXPLANATION OF PLATES.

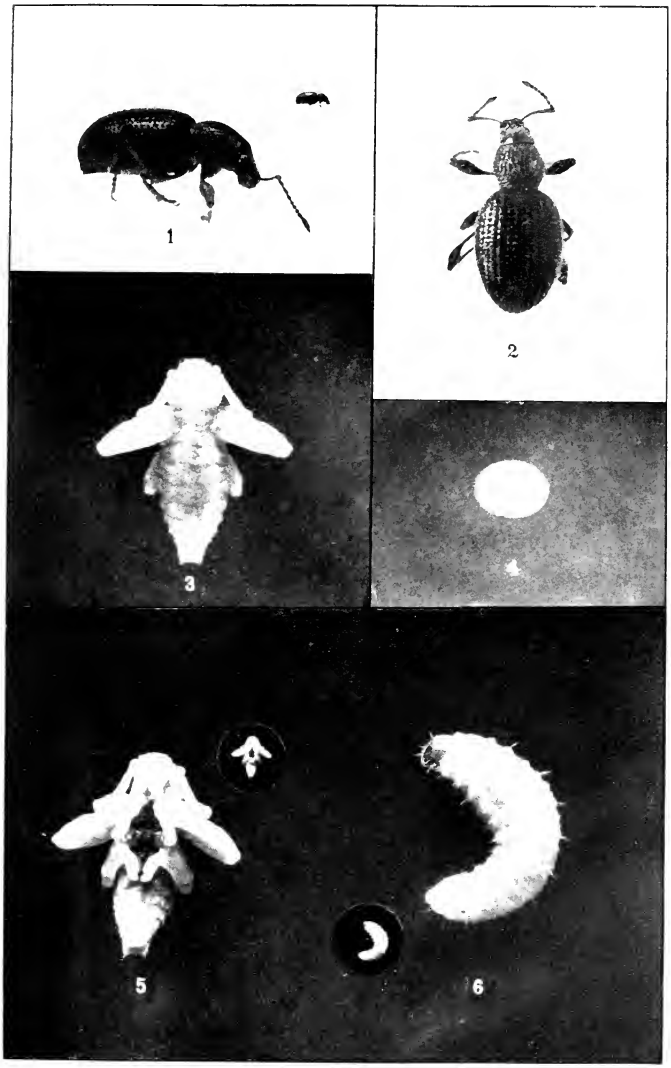
Photographed from nature from specimens secured at Missoula, Montana. The natural size of the various stages is shown in the small circles, except in the case of the egg which is almost microscopic in size.

PLATE I.

Figure 1. The adult beetle from the side.
Figure 2. Top view of the adult beetle.
Figure 3. Top view of the pupa.
Figure 4. The egg greatly enlarged.
Figure 5. Ventral view of the pupa.
Figure 6. The larva.

PLATE II.

Figure 1. Larvae taken from the roots of one strawberry plant
Figure 2. Strawberry plant showing foliage eaten by the adults of the strawberry crown girdler.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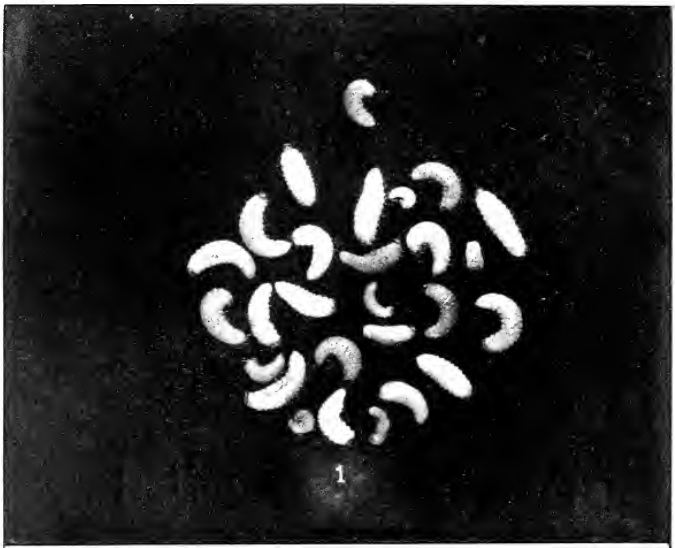

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DIPPING IN ARSENATE OF LEAD.

At the writer's suggestion arsenate of lead, secured from the Bowker Insecticide Company, was used. This substance has certain marked advantages over Paris green as an arsenical insecticide for use on the foliage of plants. Being insoluble in water it may be applied to tender leaves in much greater strength than is safe with Paris green. And there are very few insects, if any, that cannot be killed by it or driven from the plants sprayed with it. Moreover, it remains on the foliage much more persistently than does Paris green, and hence is very desirable in a climate with frequent rains that would easily wash off an application of Paris green.

We suggested to Mrs. Williams that she try dipping her plants in the substance before planting them in the field and then follow up this treatment with later sprays as new foliage appeared. It was felt that if the beetles could be driven off from the new plants the bed would be free ever afterward.

Mr. Jones watched this test and reported that dipped plants were entirely immune for about two weeks after setting and after that length of time the beetles gradually appeared and fed on the new growth that was being put forth. The foliage was then sprayed and the plants were again immune, but it was noticed that the plants were not doing well and it was found that the ingenious beetles were feeding on the roots! It will be remembered that it is the habit of these beetles to hide among the roots in the soft soil and it is not surprising, that impelled by hunger, they fell to feeding on the roots. Beside finding the roots of the plants gnawed, Mr. Jones took the trouble to make a microscopic examination of the contents of the intestine and concluded that it was composed of what had been eaten from the roots of the strawberry. The practical conclusion drawn from this test is that, while the use of arsenate of lead in the manner indicated cannot be relied upon to keep the bed free from the beetle, the treatment is probably very much better than nothing. Dipping the plants before setting them is easily done and the cost and trouble of spraying two or three times with arsenate of lead at the rate of five pounds to fifty gallons of water is not great.

The one result of our investigations that appears to be of greatest practical significance is the discovery of the fact that the trouble from the pest arises from the presence of great numbers of the

beetles, and their larvae, in the earth, living on natural food-plants at the time the soil is broken up for the planting in strawberries. Therefore the remedial measure that seems to promise most is so managing the soil that when it is desired to set out the field to strawberries the beetles will have been previously starved out; in other words the use of a cultural method. We have not had opportunity to make a practical test of this promising method but we are reminded in this connection that Mr. England, who lives just west of Missoula, some years ago was so troubled with this insect that he abandoned strawberry growing entirely, using the land for other crops. Mrs. England started in again to grow some plants, in a small way in the summer of 1904, and had no trouble whatever with the insects.

Mr. Williams' trouble has been principally on newly broken, virgin soil and we feel that if he had allowed the soil to lie fallow for one season, keeping it free from vegetation, he would have been troubled only in so far as the beetles are able to migrate into the field from the sides.

While the beetles are very general feeders, it is probable that there are crops that could be tilled that would be let alone by them and it is desirable to try planting potatoes and some other common crops, making critical examinations of the roots from time to time to learn if they are eaten by the larvae. If potatoes or any other crop is found to be immune, it may be used on virgin soil infected with this beetle and followed the next season by strawberries.

NOTES ON THE BUD MOTH.

By B. J. JONES.[1]

This insect was discussed at considerable length in the Entomologist's Report for 1903. Conditions were found to be so favorable in the cage at Missoula, however, that it was thought best to make a further critical study of it there during the summer of 1904. As the work began May 12th and ended August 22nd this study of course did not deal with the first spring activities or with the winter hibernation of the pest. The present publication may be regarded as dealing with the seasonal dates and peculiarities of its transformation, and establishes, as we believe very conclusively, a number of points in the life-history which differ considerably, in this state at at least, from the ordinary routine as worked out and published in the very excellent works of Professor Slingerland and others. As these differences have much to do with the possible effectiveness of insecticides they will be given special prominence in the present discussion, while other points already established will not be considered.

It was estimated that fully two-thirds of the flower buds on the tree in the cage, from which all of the observations were taken had been destroyed by the young larvae. Under date of May 12th it was recorded that, though varying somewhat in size, the larvae measured almost uniformly one-fourth inch in length. They were rolled tightly in dead leaves, were practically inactive during the day, and seemed quite invulnerable to any possible application of spray. They were quite dark in color and apparently ready for the first spring molt. Two days later this theory was verified, for a number of larger, fresh larvae were found in the early morning migrating from the former hibernacula and establishing themselves upon new and larger leaves. The migration soon became general and a large per cent of the worms were found to move to other quarters where they were for some time uncovered and susceptible to spray

1. The work on the bud moth at Missoula in the summer of 1904 was conducted by Mr. Burle J. Jones, a graduate from the Montana Agricultural College in the class of 1904. The outline of the work that we desired done was given him and the special problems indicated. Mr. Jones is a conscientious observer and promising student of economic entomology.

while constructing the new retreats. In building its cocoon the larva usually selected a position along the mid-rib of the leaf and began to weave a silken web back and forth, using mouth and feet. After a considerable net-work had been spun this operation was suspended and the worm proceeded to tap the mid-rib near the petiole, or the petiole itself, in such a way as to cut off the food supply. The elastic threads draw the edges of the leaf together as it wilts and, aided by the larva within, soon it is doubled, forming a secure hiding place. As the leaf withers and droops it naturally touches others of the cluster and is skilfully attached to them by its busy inhabitant. This serves a double purpose since it prevents the withered leaf from dropping and provides a very convenient feeding ground for the worm. The hibernaculum is continually enlarged and strengthened with silk, frass and scraps of leaves. In a few days it became evident that the larvae must emerge from these withered leaves in order to obtain food. This indeed was found to be the case, and each morning showed signs of renewed attacks upon the surrounding foliage. In the early morning, especially on dark, cloudy days, a large percent of them were actively engaged in these exposed places, retiring to the nest in the bright hours of the day. As a rule these feeding grounds were entirely free from the nest and upon exposed surfaces of the leaves since the larvæ in this stage do not feed upon the epidermis of the under side. This propensity to migrate to new quarters did not seem to be due to the fact that the tree was so badly infested, as might be expected, for even in this case there was seldom more than a single worm in the cluster of leaves from one twig. It was rather due to the fact that the former quarters were not only unfit for the growing worm but were also usually a considerable distance, comparatively, from desirable food. In a few cases the larvae remained in the original hibernacula, but a careful estimate showed that about 75 per cent of them did actually migrate and establish new homes. The general trend of the moving was from the center of the bole and larger limbs where the winter cocoons were spun toward the outer and younger growth.

At no time during its larval stage does the insect eat as voraciously and grow as rapidly as during this interval between the first and second spring molts, so that a considerable surface is actually repre-

sented by the feeding grounds; the caterpillars often continue their activity until the morning is well advanced. They attain to a length of between 8 and 10 mm. before retiring for the second shedding of the skin. It became evident then that this period would be especially favorable for the first experiment in spraying. Accordingly, on May 25th a limb of the tree containing 90 hibernacula by actual count was given a thorough coat of Arsenate of Lead in about the proportion of 5 pounds to 50 gallons of water. A tarred band was placed about the base of the limb to prevent migration to other parts of the tree and the ground beneath was covered by a sheet to ascertain whether or not the worms would drop to the ground, either as a means of escape or when overcome by the poison. After about two days it was evident that they were not pursuing their usual habits. Late in the day there were a number moving about on the leaves as though still in search of desirable food; many of these were on the under side of the leaves which were not so heavily coated with poison. They did not feed here, however, and even the customary haunts did not show signs of having been visited. The worms did not grow and soon began to show the effects of their abstinence; some very evidently died of poison and others shrivelled and died in the cocoons. About a fourth of the cocoons were empty and a small per cent of the larvae were found to drop to the sheet, these however were entirely those suffering from poison so that they were unable to attach their threads to the leaves.

Many ants, beetles and spiders were running about over the sheet and some were even seen carrying larvae away. An estimate of 75 per cent was recorded in the notes for the insects destroyed by this spraying, and there was no appreciable damage done to the foliage by the insects after it was applied. A final examination was made after pupation had begun and it was found that only a single worm had attained to the pupa stage.

Pupation began June 7th and by the 10th about a third of the insects were in this stage. It was often undertaken in the last hibernacula but it was especially noticeable that as many as half of the worms constructed new cocoons. These were almost entirely the product of the spinnerets, were constructed in the same way and attached in the same places as the winter hibernacula. Often the old winter quarters themselves were reconstructed and utilized for

this purpose. Though the larvae had maintained a comparative uniformity of size, the pupation lasted over a month and it was August 1st before the last belated pupa emerged as an adult moth. Branches were clipped from the tree and kept in water under small globe cages where the length of the stage was carefully recorded from the first morning after pupation until the emergence of the moth. A number of careful estimates were also made in numbered localities in the limbs. Of six successfully reared in the cans the length of the stage was as follows: 10, 13, 15, 16, 17 and 18 days, giving an average of 14 and five-sixths. Those followed in the tree gave practically the same results. This would seem to be accurate since it was June 25th before there was a general emergence of moths. On July 2nd the first eggs appeared in considerable numbers. The females did not seem to be as careful in selecting places for the deposition of the eggs as those of the codling moth, which had also laid in abundance both in and about the cage. Those of the bud moth were laid irregularly over the upper and lower surface of the leaves, the latter being considerably in the minority although still quite prominent. The eggs when immediately compared with those of the codling moth are seen to be considerably smaller, but under ordinary magnification there seems to be no definate difference in the markings. Contrary to the previous records in this State the eggs were found to be occasionally laid in clusters of from 3 to 8, sometimes slightly overlapping. This might have been due to the fact that the tree was so badly infested, though it was recorded in more eastern localities as being the ordinary method of laying. The preference of the moth for the upper side of the leaves seems to lie in the fact that it is not pubescent and the egg can be better cemented down to prevent the entrance of air. This is apparently an important item since the egg soon dies if the leaf be removed and wrinkles by wilting, or if the edge of the egg be raised ever so slightly. When laid on the under side the eggs are always carefully cemented to the surface beneath the larger hairs of the leaf. Whether this is done by the parent or is due to the plastic and adhesive properties of the eggs themselves is still, I believe, undetermined. After from 4 to 5 days the eggs turn yellowish like the yolk of a hen's egg and by the sixth day a number of reddish dots appear. A day or two before

hatching the black head and thoracic shield of the larvae show through distinctly. A number of eggs were carefully marked by means of bits of paper, string etc. and a weighted average of 11 days was obtained as the length of this stage. In laying the eggs the moths avoided almost entirely the branch of the tree sprayed on May 25th which still retained a considerable coating of the poison.

The first of the larvae began to appear on June 11 and by the 20th the insect was practically again in this stage. When free from the egg the minute larvae proceed at once to the under side of the leaves and begin to feed along the mid-rib or some of its larger branches. Usually they burrow down between the upper and lower skins of the leaf feeding and at the same time covering themselves over with frass and the pubescence of the leaves, which they weave into a solid mass by the use of their spinnerets and ever ready supply of silk. At no time in its existence as a larva is the insect without this string of silk, and wherever it is the end of this life line is always anchored securely. They have been seen to drop a distance of 3 or 4 feet before being stopped by this minute thread, and after waiting a moment for the intruder to leave wriggle back by a whirling motion to the place of attachment. With the younger lighter larvae this is a simple task but the heavy-bodied adult often breaks its life line and drops. When affected by poison the worm often neglects, or is unable to attach its thread and while throwing itself about blindly will often fall to the ground. At first the miniature grub feeds very slowly and it is some time before the feeding grounds are enlarged to any considerable extent. During this time the larvae are so closely covered by their cocoons and hidden behind the leaf veins that they are practically immune from spray of any kind. After about 14 days however they begin again to have a definite routine, making nightly rounds from their cocoons to the more distant parts of the leaves. As they grow and extend their ravages they are of course more unprotected and feed upon a greater per cent of the exposed cuticle. At about this time the grubs apparently foresee a need of extra supplies and as their habitats wither they begin to stick other leaves to them. This is done very skillfully and cleverly; the flat surfaces of the leaves are fastened together and the worms feed within, free from any possible invader. At the first indications of this propensity it was seen that the leaves

must be coated with poison before they were fastened together and on July 15th, before a large per cent of the worms had begun to fasten the leaves together, a part of the tree was given a thorough spraying of arsenate of lead in nearly twice as strong a solution as that formerly applied. Special attention was given to coating the under side of the leaves.

It was naturally some time before the effect of this spraying became evident, since it was not until about July 30th that the process of fastening leaves together in the construction of the so-called houses, which has been so thoroughly discussed in previous publications, began to come into prominence on other parts of the tree. It was now noticeable that these transformations were not going on in the sprayed limbs. A careful examination of the larvae here showed that while they were largely still active, bewteen 5 and 10 per cent only being found dead, yet their ravages had been confined almost entirely to the leaves upon which they had hatched,and that even here the feeding was far down under the coating of poison and not extended as in other parts of the tree. On August 6th the per cent of dead larvae on the sprayed limbs had increased considerably and there was very little noticeable extending of the feeding grounds. By August 18th the condition was still more aggravated, and when on the 22nd a final examination was made the effect of the poison was very evident. On unsprayed parts of the tree the leaves were largely turning brown as a result of the ravages of the worm and the "Houses" consisted of from 2 to 5 leaves. The sprayed parts were practically free from clusters of leaves fastened together, and the foliage was still fresh and green. Though a small per cent of the worms were still alive they were not developing as rapidly as the others and, judging from the observations taken at the first spraying, would never live to go into winter quarters.

The summer was unusually dry and only two heavy rains had taken place since the first spraying on May 25th. That limb was now, on August 22nd, by far the freshest on the tree and most free from attack, and still retained a considerable film of the Arsenate of Lead.

While the experiments given above were limited in their application they certainly show that the range of control of this pest is much wider than was formerly supposed. The fact that the larva

feeds entirely on the leaves after its first spring attack on the opening buds, makes its control a much more tangible problem than that of the codling moth, where the surface feeding is confined to the single hole which it makes in the fruit,; and the fact that the bud moth is actually without covering during a part of the larva stage and feeds upon exposed surfaces, makes the problem still more simple. This does not mean that the insect does not require the most rigid and persistent treatment, nor is it intended to indicate that it will fall an easy prey to an ill-timed and carelessly applied application of poison.

WHEN TO SPRAY.

Certainly the best time for the first application is in the spring before the flower buds begin to open. The cocoons of the insect should be closely watched and the spray applied as soon as there are signs of activity, or even before if the area to be covered is large enough to consume a considerable length of time, since it is fatal to allow the worms to enter the young buds. The larvae are already advanced in size and have only to proceed to the opening flowers of the nearest twigs, which, by a remarkable instinct of the worms when hibernating in the fall, are usually upon those at the base of which their cocoons are securely fastened, in order to do immediate damage. It is this stage that the orchardist should be especially anxious to control since it is at this time that the damage is done and when the insects are allowed to get well within the opening flowers they are practically safe until the apple crop has been "Nipped in the bud." At this time, however, they are feeling the effects of a long winter's fast and will be very susceptible to the poison if it be very completely and thoroughly spread. But the applications should not end with this, and if there are worms still to be found on the tree, and a few are certain to survive even the most rigid treatment, their habits should be closely watched and as soon as they begin to feed in exposed places they should be again treated to spray. This application should be made at the time that the larvae complete the first spring molt and begin to seek new and larger quarters, such a stage as that described above which occured about May 25th at Missoula. Even after the summer brood emerges from the eggs the prudent orchardist will find it to his advantage

to pursue them with the ever ready spray pump and nozzle, before they begin to fasten the leaves together. The disadvantages of spraying at this time are: that it is rather difficult to get a thorough coat of poison on the under side of the leaves where the worms are now feeding, that the pubescence of the under side prevents the spray from adhering as closely and uniformly as above, and finally that the fruit, where the trees are bearing, is now ripening in many cases and there is more or less danger of having a coat of poison upon it when it is ready for market; the application can be timed, however, in most cases so as to avoid this trouble. A coat applied when the eggs were still unhatched would cleave sufficiently to make life very uncertain for the resulting larvae. The advantages of spraying at this time are: that the leaf buds have ceased to grow and the spray is good as long as it retains its poisonous properties, since there is no danger of the trees outgrowing it and making fresh feeding grounds for the worms as is the case with the earlier applications. In this advanced stage the foliage is also very resistant and the mixture can be applied at a greater strength than formerly, which up to a certain limit, makes it much more adhesive. As a general rule where trees are infested by this insect keep the the early buds and blossoms sprayed by all means, whether it requires one, two, or three applications, and spray later if the insect is still present.

HOW TO SPRAY.

This has been widely discussed in bulletins dealing entirely with the subject of spraying and requires only a word here. As a complete and even distribution of the spray is the principal thing to be attained in dealing with this insect a Vermorel, or similar nozzle that will give a wide and fine distribution to the liquid, should be used. In putting on the first spray the operator should not confine his attention to the buds alone but should give the leaves a thorough coating, since the object is not only to keep the insect from doing immediate damage, but to kill it if possible. This of course should be done from an elevated platform, or by means of a long bamboo stick or rod attached to the nozzle so that the topmost branches can be reached and the upper side of the leaves thoroughly covered. In dealing with the summer brood it is

necessary to thrust the apparatus through the limbs in such a way as to coat the under side of the leaves. The operator had best protect himself from drippings by rubber garments or old clothing for which he has no further use. With arsenate of lead it is always necessary to keep the mixture within the pump well churned in order to get an even distribution of the poison, as the heavy lead compound settles rapidly. This is best accomplished by the use of a pump with an agitator provided for that special purpose, but may be done on a small scale by frequently turning the spray back upon itself through the nozzle, or by other methods of churning.

WHAT TO SPRAY WITH.

As the experiments recorded above dealt only with arsenate of lead we can of course give its relative value with other sprays only by the results obtained from their use in other localities. It is only fair to say in this connection that in the present instance it has given much better results than those recorded from the use of others in other places where it was reported that their effectiveness was not encouraging. It is especially favorable for the first spring application as the young buds at that time are quite delicate and will not always withstand the Paris green compounds, which are likely to burn them at that rainy season of the year. The arsenate can be safely applied at that time in the proportion of four and a half to five pounds in 50 gallons of water; the second dose, if it be applied after the blossoms have gone, may be increased to 5 and a half or six pounds, and the third as much higher as the condition of the fruit will allow.

NATURAL ENEMIES OF THE BUD MOTH.

The natural enemies of this pest must not be overlooked since they form no small element in its control. The enormous multiplication of the moth within the wire screen composing the cage as compared with neighboring trees outside, shows the remarkable effectiveness of birds and the larger insects in reducing its numbers. Within the cage numerous parasites were always in evidence. It was found that larvae or pupae left about the cage were invariably taken by ants which were always running up and down the trees

and over the ground. A number of instances came to my attention during the summer where these doughty little soldiers had found unprotected larvae and were struggling away down the tree with them. A small per cent of the pupa cases opened were found to contains Chalcid flies in various stages of existence. Usually these had devoured the pupae and were completing their transformations neatly enclosed in the pupae of their former hosts. Quantities of large gray spiders were always in and about the tree and in the crevices of the cage.. In a number of cases the adult spider built her nest and laid her eggs upon leaves containing bud moth larvae. These spiders were most noticeable during the pupation period in July and it was found that the crevices of the cage were filled with cocoons of the bud moth containing adult larvae or pupae. Nests containing young spiders were invariably stored with them and the cocoons were speedily emptied by the young Arachnids. While it is never safe to rely entirely upon natural enemies for the control of the pest, yet they deserve a large share in the orchardists's consideration and should never be destroyed by him.

SOME INSECTS TO BE WATCHED FOR BY OUR INSPECTORS AND FRUITGROWERS.

We have attempted to bring together in the following pages information that will be of value to our horticultural inspectors, fruitgrowers and others interested in the preventive campaign Montana is making against insect pests of fruit. We believe that the geographical arrangement of the valleys of Montana which have climatic conditions that permit of the successful growing of fruits make it possible to do much to prevent the introduction and spread of insects and fungus pests. The different fruit regions are so isolated one from another that pests from any one infested region in the state are scarcely more liable to be transferred to another than are the pests from an infested region outside of the state. It is therefore of the greatest importance that all persons interested in the fruit industry should acquaint themselves with the appearance of the pests that are most liable to be introduced. We have included in the list here discussed, various species that have appeared in one

or another locality while those that are already widely distributed and well known, such as the apple leaf-aphis, have been excluded.

Not all of the species in the list can be considered to be pests of first class importance in our climate but they are all species that for one reason or another, usually because they feed in the fruits that are liable to be shipped into the state or because they hibernate in or on some part of the trees that are shipped in as nursery stock, are liable to come across our borders incidentally in commercial practices.

THE PEACH-TREE BORER.

Though the peach-tree borer shows a decided preference for peach trees it is also a pest of cherry, plum, nectarines and apricots. The insect is therefore of interest to the fruit-growers of Montana, though few peaches are grown. It is not probable that it will become a very serious enemy of cherries and plums, but it is thought best to include it in the list here treated.

The young larva burrows beneath the bark and sap wood during the first year of its life and passes the winter in this burrow. In the spring it resumes feeding, reaching full growth in May or June. In its hibernating condition it is liable to be transferred on nursery stock . .

It s a difficult pest to control and one that should be vigorously dealt with if it is found in Montana. Its presence on growing trees is indicated by gummy extraction from the bark at the points where its burrows touch the exterior.

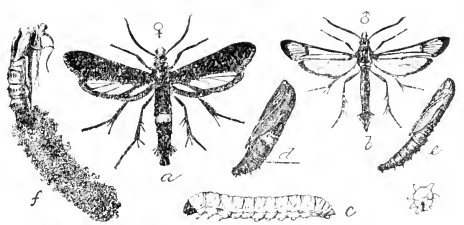

Fig. 2. **The Peach-tree Borer:** a, female; b, male; c, larva; d, e, female and male pupae; f, cocoon. (Marlatt, Circular 17, New Series, Div. of Entomology, U. S. Dept. of Agr.)

THE FLATHEADED APPLE-TREE BORER.

The flatheaded apple-tree borer inhabits Canada and the United States and is a native American insect. It occurs in few places in Montana and in some cases has been very destructive. Young trees during the first two years after planting are particularly liable to attack since the beetle prefers for its host trees those that have been weakened from some other cause. The hot southwestern sun in the spring of the year often "scalds" the bark on the main stem of young trees. Trees thus affected are attacked and their destruction is completed.

Various forest and shade trees are attacked as well as apple, pear and peach among fruit trees.

The female deposits her eggs in cracks and crevices of the bark in the spring and early summer. The larva hatching from the egg bores through the bark and excavates cavities of varying shape and size in the sap wood. Small trees are often girdled. The larva life lasts from one to three years and it is while in the larval burrows that the insect is liable to be distributed on nursery stock. The appearance of the insect, magnified, is shown in the accompanying figure.

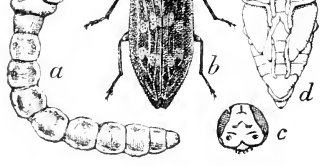

Fig. 3. **Flat-headed Apple-tree Borer:** a, larva; b, beetle; c, head of male; dk, pupa—twice natural size. (Chittenden, Circular 32, Sec. Series, Div. of Entomology U. S. Dept. of Agr.)

ROUND-HEADED APPLE-TREE BORER.

The round-headed apple-tree borer is much less frequently met with than the "flat-headed" species but its injury is more serious. Affected trees assume a sickly appearance and fail to make the proper growth. On the trunks may often be seen masses of the castings at the openings to the burrows. In some parts of the country this has been a very serious enemy to apple trees.

Besides attacking the apple it is found in various other woody plants including crabapple, quince and pear. Experience has shown that trees are very much more liable to be attacked if the trunks are surrounded by grasses, weeds or other vegetation.

The adults appear in the spring of the year and the females deposit their eggs as near to the ground as possible. The eggs hatch in about three weeks and the larvae work their way under the bark and feed for the first season in the sapwood. During the second season they feed in the deeper heartwood and in the third spring bore to near the surface where they transform to pupae the adult beetles appearing a little later. The adult is a beautiful insect measuring three fourths of an inch to an inch in length. The under surface of the body is silvery white while the upper surface is brown with two longitudinal white stripes.

This insect may be introduced into Montana in nursery stock. In looking for it the bases of the trunks should be closely examined.

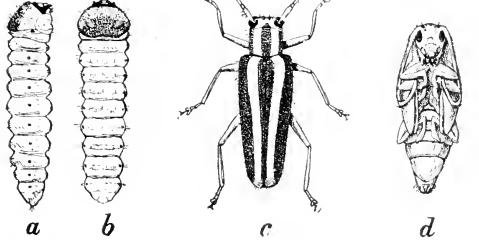

Fig. 4. **Round-headed Apple-tree Borer:** a, larva, from side; b, from above; c, female beetle; d, pupa; all enlarged one-third. (Marlatt, Circular 32, Sec. Series, Div. of Entomology, U. S. Dept. Agr.)

THE BRONZE APPLE-TREE BEETLE. 1

This beetle, so far as we are informed, is confined to the Northwestern States and its economic status is not fully determined. Mr. F. H. Chittenden has given us a good account of what is known regarding the pest, in which he calls attention to various complaints regarding it from Washington and Oregon.[2] Professor C. V. Piper formerly from Pullman, Washington had sent specimens to Mr. Chittenden reporting serious damage to the apple industry of Washing ton. The same gentleman later reported that his first suspicions regarding the weevil had been much allayed by the discovery of the fact that its injuries were apparently secondary to the fungus disease known as "canker" or "blackspot".

In an orchard near Missoula an assistant Mr. jones, found last summer specimens which on being submitted to Dr. Howard of the Bureau of Entomology proved to be this beetle. The owner of the orchard is very jealous over the freedom of his trees from pests and has repeatedly sent this office specimens for identification. The "canker" disease has not yet been detected in his orchard though the beetle in question is fairly abundant on his trees.

These facts cannot be considered as evidence that the beetle is secondary to the fungus disease yet they point in the oposite direction. To the writer it seems possible that the fact that Prof. Piper

Fig. 5. The Bronze Apple Tree Borer: a, adult weevil dotted portion of size line showing length of snout; b, larva; c, pupa—six times natural size. (Chittenden, Bulletin 22, New Series, Div. of Entomology, U. S. Dept. of Agr., 1900).

1. *Magdalis aenescens* Lec.
2. Bulletin 22, N. S. Div. Ent., U. S. D. A., page 39.

found the fungus disease and the beetle at identical spots on apple trees may be explained by the germinating spores of the fungus disease finding in the punctures into the bark made by the beetles in depositing their eggs, suitable places for gaining access to the under layers of the bark. If this be the case then the weevil is the primary cause and the fungus secondary.

Considering what information we now have regarding this borer, it is apparent that in the interests of the apple growers it will be well to watch for it and become familiar with its habits.

The beetle is small, black, and has a snout. See the accompanying figures.

Fig. 6. Work of the apple tree borer:—a, pupa in its cell; b, exterior of pupal cell; c, empty cell; d, parasitic pupa in its cell; e, two empty cells of parasite; f, beetle and holes made by beetles in their escape—all natural size. (Chittenden, Bulletin 22, New Series, Div. of Entomology, U. S. Dept. of Agr., 1900).

THE APPLE TWIG-BORER. 1.

The apple twig-borer also known as the grape cane borer is an enemy to the grape, apple, pear, peach, plum, forest and shade trees, and ornamental plants. It is especially destructive to the grape.

This has been a very common and destructive pest in the states along the Mississippi river from Iowa southward. It also occurs eastward from the Mississippi river to the coast.

In the fall and winter the adults of this insect bore into the twigs of its host plants as shown at "d" of the accompanying figure. Entering these stems the beetles hibernate there. It is thus seen

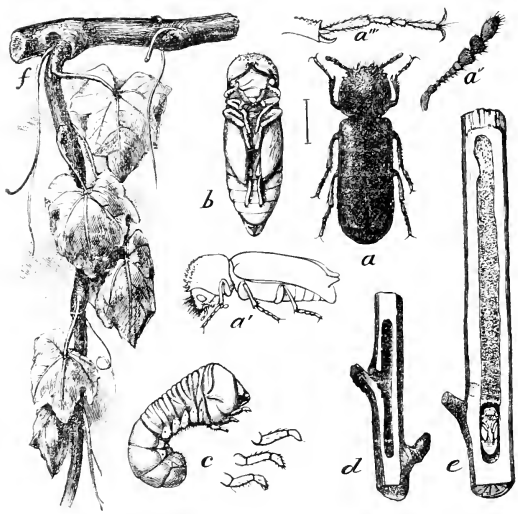

Fig. 7. The Apple Twig-borer: a, beetle, dorsal and lateral view. b, pupa from beneath; c, larva from side, with enlargements of the thoracic feet; d, burrow in apple twig made by adult; e, larval gallery in tamarisk, with pupa in cell at end; f, injury to young shoot and cane, showing the entrance to burrow of beetle near f and the characteristic wilting of the new growth—all much enlarged except d, e and f. (Marlatt, Yearbook, U. S. Dept. of Agr. 1895.)

1. *Amphicerus bicaudatus.*

that from this fact the apple twig-borer is another pest that is particularly liable to be transferred on nursery stock. The eggs are laid in the early spring months, the beetles leaving their hibernating quarters for this purpose. The larva bores through the center of the twig until fall when it pupates later transforming to a beetle and going into hibernation as above described. There is but one brood.

The adult of the insect which is the form liable to appear on nursery stock is about ½ inch in length, cylindrical in general shape and brown in color.

THE FRUIT-TREE BARK-BEETLE.

The fruit-tree bark-beetle is an introduced insect that attacks the bark of plum, peach, cherry, and apple trees. The bark may be thickly peppered with fine holes as though by fine bird shot. See figure 9. These are the entrance and exit holes of the small beetle illustrated, greatly enlarged at Figure 8 a and b. The grubs excavate narrow galleries in various directions under the bark often killing a tree or part of its branches. The beetle usually attacks only sickly or unthrifty trees.

The adult beetles appear in the spring and begin burrowing through the bark. Upon reaching the sap wood, feeding as she goes, the female constructs, partly in the bark and partly in the wood next to it, a vertical gallery or "brood chamber", and along the sides of this at short intervals she gnaws little pockets in each one of which she deposits an egg. The very minute, whitish, grub-like larvae that hatch from these eggs excavate galleries that start out at right angles to the brood chamber. These side galleries soon

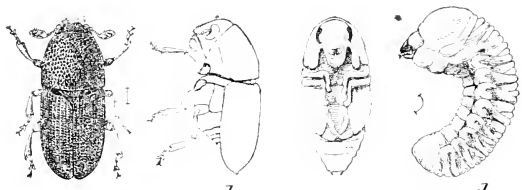

Fig. 8. **The Fruit-tree Bark-beetle:** a, adult beetle; b, same in profile; c, pupa; d, larva—all magnified about ten times. (Chittenden, Circular 29, Sec. Series, Div. of Entomology, U. S. Dept. of Agr.)

diverge, however, and increase in size as the growing larva gnaws its way away from the main burrow. Most frequently the insect lives in such numbers, with its larval galleries so closely packed together and so much confused with others that it is with difficulty that individual galleries can be distinguished.

The larvae transform to pupae at the end of their galleries. The number of generations varies in different parts of the country between one or two and four.

The species is a fairly common one in the eastern part of the United States and may appear on nursery stock shipped in for planting in Montana.

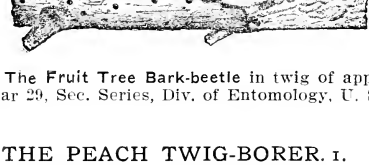

Fig. 9. Work of **The Fruit Tree Bark-beetle** in twig of apple—natural size. (Chittenden, Circular 29, Sec. Series, Div. of Entomology, U. S. Dept. of Agr.)

THE PEACH TWIG-BORER. 1.

In Montana markets one may occasionally find peaches containing the larvae of this insect and from its peculiar hibernating habits it is greatly facilitated in its distribution on nursery stock.

The peach twig-borer is a pest of stone fruits and is very widely distributed. From what is known of its habits it seems evident that should this pest gain access to the peach, plum, and cherry trees of this state much injury might result.

The presence of this insect on nursery stock is indicated by bits of frass attached to the bark frequently in the crotches of branches of twigs. Each of these bits of frass covers the entrance into a small burrow within which a young larva may be found. The larva at this stage is of yellowish color with the head, the top of the segment just behind it, and the posterior end of the body above, almost black. In the spring when the shoots have begun to grow the young larvae leave their hibernating quarters and bore into the

1. *Anarsia lineatella.*

tender leaf-shoots. When one leaf shoot has dried so as to become unsuitable for food another is attacked. The larva becomes full grown in about two weeks and pupates in a rather unsubstantial cocoon among withered leaves or on the surface of the bark. The moth issues in May and is very small and grayish. Two later broods occur, the larvae boring into the twigs as described or into the fruit. The larvae of this second brood construct the burrows in the bark in which to hibernate.

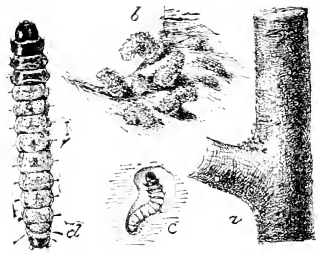

Fig. 10: The Peach Twig-borer: a, twig of peach, showing in crotch minute masses of chewed bark above larval chambers; b, latter much enlarged; c, a larval cell, with contained larva, much enlarged; d, dorsal view of young larva, more enlarged. (Marlatt, Farmer's Bulletin 80, U. S. Dept. of Agr., 1898.)

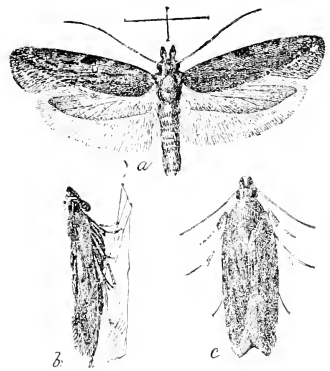

Fig. 11: The Peach Twig-borer: a, moth with spread wings; b and c, same with wings closed, illustrating position normally assumed—all much enlarged. (Marlatt, Farmer's Bulletin 80, U. S. Dept. of Agr., 1898.)

THE STRAWBERRY CROWN MOTH. 1.

The Strawberry crown borer is a dangerous enemy to the strawberry, blackberry, and raspberry. The adult is a member of the group known as clear winged moths on account of the transparency of the wings. They resemble wasps in their form, markings, and actions.

This species appears to be native to the United States and has been recorded by the Bureau of Entomology at Washington from California, Nevada, Colorado, and Texas.

A lady from Stevensville, Montana, made complaint of what is very likely this insect but no material could be obtained from which to make a determination of the species though an insect which was plainly a Sesiid from the manner in which it left the pupa shell protruding from the stems just above the earth. This pest had practically destroyed her entire patch of blackberries.

This again is one of the insects which is liable to be introduced on nursery stock. The partly grown larvae pass the winter in the crowns of the host plants. Just before the emergence of the moths the pupa works itself part way out through the opening previously constructed by the larva and the shell of the pupa is left at the opening when the moth departs. This is an insect that is not easy to control and its advent should be guarded against.

THE WOOLLY APHIS.

The woolly aphis is an insect much feared by fruit growers but after six years of experience in the state of Montana during which time we have learned of its presence fairly common in the state we feel warranted in saying that under the climatic conditions found here this insect will probably not be a serious pest. However, it is warrantable to watch for it and deal vigorously with it when found.

Two forms of the insect exist, an areal form feeding on the parts of a tree above the earth, and a root form feeding on the smaller roots on which they produce irregularly shaped galls.

The areal form often attacks partly healed wounds in the bark.

1. *Scsia rutilans* H. Edw.

The bodies of this form are covered by a white flocculent matter, and when several of the insects are huddled together as is usually the case with this louse, the white blotches become conspicous objects.

The insects' most natural means of wide dissemination is on the roots of apple trees intended for planting.

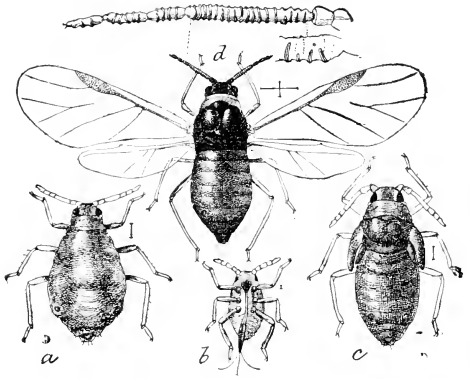

Fig. 12. **Woolly aphis:** a, agamic female; b, larval louse; c, pupa; d, winged female with antenna enlarged above; all greatly enlarged and with waxy excretion removed. (Marlatt, Circular 20, Sec. Series, Div. of Entomology, U. S. Dept. of Agr.)

THE SAN JOSE SCALE.

The San Jose scale is an oriental insect but it was first noticed in literature from the town in California from which it took its name. It is now of world wide distribution and has been the cause of much loss and expense. Of small size and insignificant appearance but very tenacious of life and endowed with great powers of multiplication, it has been an enormous factor in the fruit growing and nursery businesses.

The San Jose scale is a general feeder, attacking nearly every variety of decidous fruit trees. In the east it has done its principal damage to peach and pear but its full list of food plants includes many ornamental plants and shade trees.

It passes the winter as a partly grown female. In the spring young are produced which wander off and finding suitable places on

the plant settle down and begin feeding. Other broods follow, the number varying with the latitude.

The female scale is circular about one-twelfth of an inch in diameter when full grown and only slightly convex. It is gray or blackish sometimes with a yellowish tinge.

The mature male is oblong-oval, its length being about one-half the diameter of the female scale, black or grayish and having in the center a nipple-like prominence. See the accompanying figure.

It is a source of wonder to many that an insect so small as the San Jose scale can overcome a tree. The explanation is found in the fact that the life of the tree exists just under the bark upon which the countless numbers of scales settle inserting their beaks into the vital tissues just under the surface. While these insects

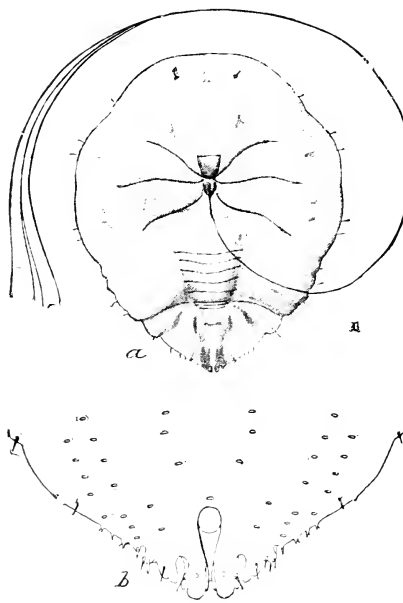

Fig. 13. **San Jose Scale:** a, adult female showing very long sucking setae; b, anal plate showing characteristic ornamentation of edge; greatly enlarged. (Howard and Marlatt, Bulletin 3, Div. of Entomology, U. S. Dept. of Agr.)

may not kill a tree outright they may so blight it as to render it useless.

The question is often asked: "Would the San Jose scale become a serious pest in the latitude and under the climatic conditions of Montana"? While there is room for a reasonable doubt that this scale would be a serious menace to Montana fruit trees, the fruit growers should keep the benefit of the doubt on their side and urge the enforcement of the laws that are intended to prevent its admittance and should watch for, and if possible, suppress it as it comes.

It is true that in localities where it thrives methods are now devised whereby it may be held in control but the application of these means is expensive and the presence of the pest is a cause of anxiety to the owner of the infested premises.

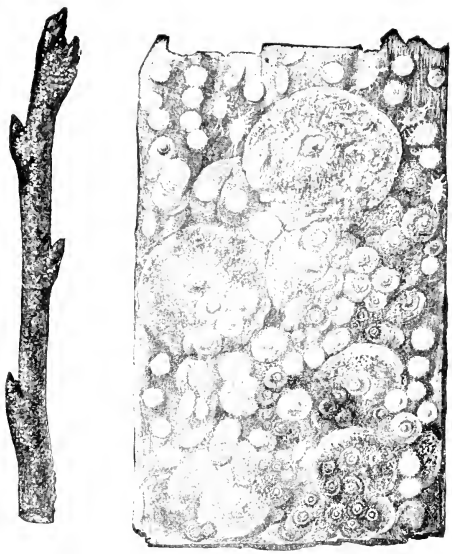

Fig. 14. San Jose Scale: a, infested twig natural size; b, as the scales appear under a hand lens. (Howard and Marlatt, Bulletin 3, New Series, Div. of Entomology, U. S. Dept. of Agr.)

PUTNAM'S SCALE INSECT. 1.

Putnam's scale insect is widely distributed and feeds on all orchard trees. It is similar to the San Jose scale in general appearance but it may be easily distinguished from that species by the orange colored spot (the exeuvia) on the scale of this species and the less circular outline.

This insect is single brooded. It passes the winter in a nearly full grown condition. The young begin to hatch in July and continue during the month.

Putnam's scale has been taken by the writer near Missoula in an old orchard and on an old neglected tree in the city of Missoula.

THE GREEDY SCALE INSECT. 2.

Smith cider and other varieties of apples coming into the Montana market from California occasionally bear specimens of this scale insect. We have seen apples with many specimens of this species crowded in at the blossom and stem ends. It is not a species that could survive our climate and need not be feared as a pest on apples in Montana. It is common in greenhouses where it reproduces in great numbers.

The scale is gray in color but somewhat transparent so that when covering the yellow body of the living female the scale has a yellowish tinge. When removed from the bark or fruit a white scar is left.

The adult female scale is very convex and among scale insects is conspicious for this characteristic.

It is widely distributed in the United States and is without much doubt an introduced species.

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1. *Aspidiotus ancylus* Putn.

2. *Aspidiotus camelliae* Boisd.

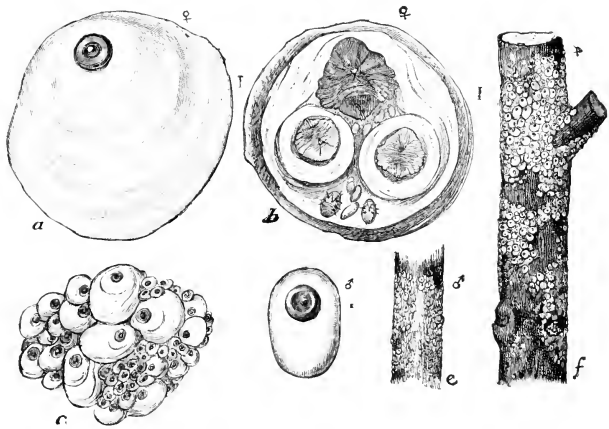


Fig. 15. **The Greedy Scale Insect:** a, female scale from above; b, same from below; c, mass of scales as appearing on bark; d, male scale; e, male scales on twig; f, female scales on twig; e and f, natural size; c, considerably enlarged; a, b, d, greatly enlarged. (Howard, Yearbook, U. S. Dept. of Agr., 1894.)

THE OYSTER-SHELL BARK LOUSE.

The oyster-shell bark louse is the best known of any of the orchard scales. It probobly came originally from Europe but it is now known throughout the world. Like the other scale insects here discussed it is particularly adapted to distribution on nursery stock.

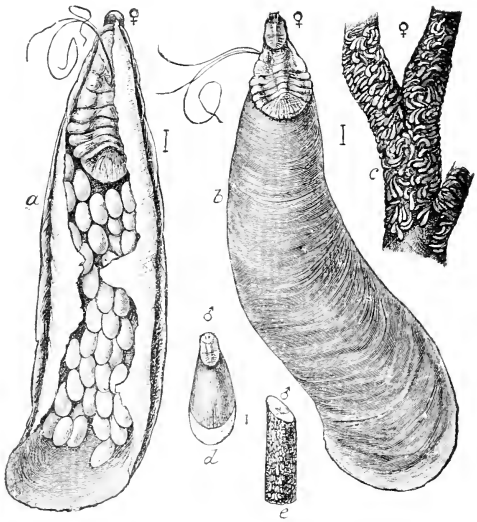
This insect attacks a variety of food plants including apple, pear, plum, quince, hawthorn, raspberrq, currant, linden, willow, cottonwood, poplar, wild cherry, rose, lilac , and white birch. Many of these it attacks so severly as to threaten their lives.

The scales of the two sexes are quite different in size and appearance. The female scale is elongated (see "a" of the figure) rounded on the upper surface, flat beneath, and brownish in color. The male scale is much smaller but of the same color.

If one of the female scales be turned over during the winter there may be seen numerous very minute white eggs closely packed

together. With the awakening of nature in the spring these eggs hatch into minute whitish larvae which crawl out from under the parent scale and go to suitable spots for settling down. These larvae go mainly to the tender new growth. In the North there is but one brood but farther south there are two.

This scale insect is present in a few localities in the state and has been very prolific and troublesome.



eggs; b, same from above, greatly enlarged; c, female scales; d, male scales, natural size. (Howard, Year-book, U. S. Dept. of Agr.)

Fig. 16. **Oyster-shell Bark-louse:** a, female scale from below showing

THE SCURFY BARK LOUSE.

The scurfy bark louse is an elongated insect similar in shape to the oyster shell bark louse but the substance of the scale is thinner in texture and white in color. (See the accompanying figure).

The winter it passes as eggs closely packed under the scale. The eggs number from thirty to seventy-five and are of a reddish purple color. In the climate of northern United States there is but one brood. The eggs hatch in the spring and by fall the life cycle, which is similar to that of the oyster shell louse, is completed.

This species is not very liable to be introduced on nursery stock. The white color of the scales renders them conspicuous objects and the nurseryman who desires his trees to have a clean healthy appearance will usually notice them and remove them before shipping. The oyster shell bark louse, on the other hand, is not noticeable, its color being similar to that of the bark.

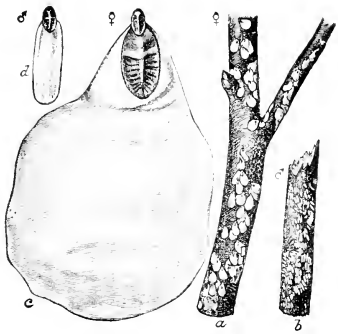


Fig. 17. **Skurfy bark-louse:** a, c, females; b, d, males; a, b, natural size; c, d, enlarged. (Howard, Year-book, U. S. Dept. of Agr.)

OTHER SCALE INSECTS.

There are a few other scale insects that might be discussed in this paper but which are not liable to often appear on nursery stock arriving in Montana.

Scale insects are not easily identified except by the expert, and much may depend on the identity of a scale that is found in an orchard or nursery. The Experiment Station will gladly make determinations of scale insects or any others that are sent in.

THE CODLING MOTH OR APPLE WORM.

The well known apple worm is enormously destructive to apples and pears in the United States. It is said to destroy, on an average, about one half of the apple crop of the United States annually. Its injuriousness is much less in Montana than in some other states where the climatic conditions are more favorable to it but we believe that the percentage of damage under ordinary conditions will vary from about 15 to about 55 when nothing is done to hold it in check. The apple is Montana's most successful fruit and the codling moth its worst insect enemy.

The codling moth is two-brooded in Montana. The first eggs of the season are laid about the middle of June. By the latter part of July wormy apples become noticeable. The second brood begins its operations about the 10th to the 15th of August and is principally injurious to fall and winter varieties.

It occurs in a few isolated localities in the following counties: Flathead, Sanders, Missoula, Ravalli, Broadwater, Yellowstone, and Custer.

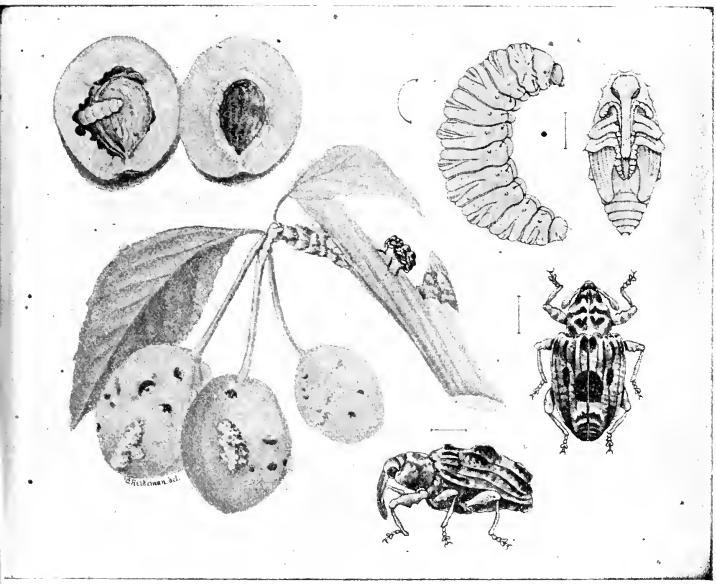
For means of wide distribution the codling moth is mainly dependent on traffic in fruits. It has extended itself throughout practically the whole world and is believed to have done so almost entirely through the medium of fruit packages. It is a particularly dangerous practice to carry second hand fruit boxes into the orchard to be filled again. This practice is now prohibited by law.

Fruit growers should heartily co-operate with the state authorities in the campaign against this pernicious insect.

THE PLUM CURCULIO.

The plum curculio is a serious enemy to stone fruits and is partial to plums. The accompanying illustration shows its method of injuring plums. It is an insect pest of first class importance and has in some sections practically killed the industry of plum growing. Besides attacking the plum it breeds in great number in cherries, peaches, appricots, nectarines, quinces, apples, crabs, and haws.

Its means of distribution is principally in the larval stage through



18. **The Plum Curculio,** (Lugger).

the medium of crated cherries shipped from one locality to another. It hibernates as an adult and may be distributed in this stage.

Its presence may be detected by the characteristic cresentic slits that it makes on the young fruits that it attacks and by the grub in the fruit. However, there are other insects that feed in stone fruits.

This is a native American insect. It is said to occur near Stevensville, Montana, and in Yellowstone County.

TENT CATERPILLARS.

There are about five species of tent caterpillars that are liable to be found in Montana. We have already had a few complaints of these insects and the writer saw a nest of what was probably the common eastern species, (*Clisiocampa americana*) in Missoula county. Within certain limits the caterpillars of all these species appear alike and the accompanying illustration will give a reliable idea of the general appearance.

The winter is passed in the egg stage. The egg clusters shown in the accompanying figure are liable to occur on any bill of nursery

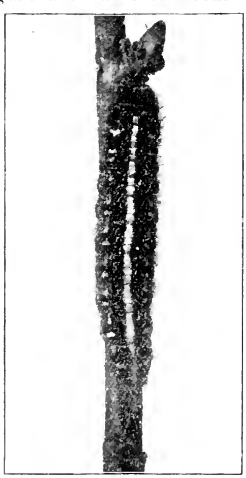


Fig. 19. Clisiocampa americana: top view of full grown caterpillar. (Lowe, Bulletin 152, N. Y. Agl. Exp. Sta.)

stock. One would not be warranted in rejecting the shipment or burning it. The egg clusters are easily removed, or if they escape detection and hatch in the trees after they are set out, the nests are conspicuous and easily destroyed. There is little excuse for allowing this insect to continue in an orchard year after year. The nests may be removed caterpillars and all without injury to the trees. Wild cherry trees in the vicinity of the orchard should be kept free from the nests so as to prevent infection of the fruit trees.

The caterpillars hatch from the eggs early in the spring and congregate in a forked limb or branch and spin a nest or "tent". This is their home from which they migrate for the purpose of feeding.

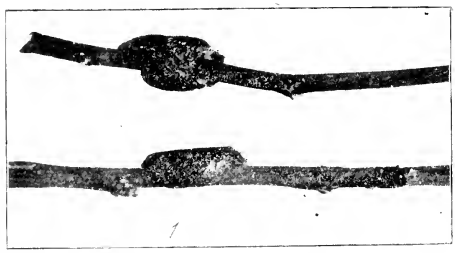


Fig. 20. Egg masses of Clisiocampia americana. (Lowe, Bulletin 152, N. Y. Agr. Exp. Sta.)

THE BUD MOTH. 1.

The bud moth is a small, brownish, hairless, black headed caterpillar about ¼ of an inch long which feed in the buds of apple and pear in the spring of the year, and after the buds have expanded,

1. *Tmetocera ocellana.*

on the leaf and flower buds which they destroy. Later in the season the new brood feeds on the epidermis of the leaves. The injuries from the species are due to the destruction of the fruit buds and to the deformities induced by the eating off of terminal buds.

The adult is a moth somewhat resembling the codling moth. The eggs are laid on the foliage about the first of July. The winter is passed as a partly grown larva in a hibernaculum constructed for the purpose. These hibernacula are very difficult for an inspector to detect and the insect is one that may readily be distributed on nursery stock, scions, etc.

The bud moth has been periodically injurious in the East. In another part of this report are notes on the life-history and means of controlling its ravages.

The species occurs at Missoula where it has been very injurious. I have also found it on a few trees twelve miles up the Bitter Root Valley and for a short distance up the Rattlesnake Valley.

A reasonably complete account of this insect was given in the First Annual Report of the State Entomologist, (1903).

Fig. 22. Work done by **bud moth larvae** early in season on apple twig. (Slingerland, Bulletin 147, Corn. Univ. Experiment Station.)

THE PEAR AND CHERRY SLUG.

The larvae or slugs of this insect feed on the upper surface of the leaves leaving a network of veins and the lower cell layers. The leaves so affected turn brown, die and drop off. Whole trees or whole orchards may be thus defoliated. A second growth may be put out thereby weakening the tree so that no fruit is produced the next season. In the early spring the adults may be seen about the treeswhere they gather for the purpose of laying their eggs. The larvae soon hatch and feed on the leaves. They are at first white, but they soon have a shiny olive colored fluid on their bodies.

The insects feed on pear, cherry, and plum and about thirty other plants. It shows a preference for pear.

The species occurs throughout Europe and America and in many of the British colonies.

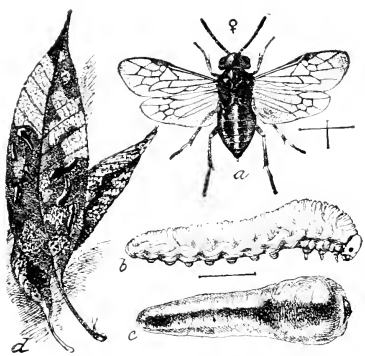


Fig. 22. **Pear and Cherry Slug:** a, adult saw-fly, female; b, larva with slime removed; c, same in normal state; d, leaves with larvae, natural size; a, b, c, much enlarged. (Marlatt, Circular 26, Sec. Series, Div. of Entomology, U. S. Dept. of Agr.)

THE PEAR-LEAF BLISTER-MITE.

The pear-leaf blister-mite is another pest that is particularly liable to be distributed on nursery stock, scions, etc. The almost microscopic mites hibernate under the scales of the buds and their detection through inspection is out of the question.

In the spring as the young, tender leaves are being put forth the over-wintered mites pass to the under side of the leaves and produce whitish or reddish blisters under which they later produce young which migrate and cause new blisters.

The pest is severe on individual trees but does not spread rapidly. Over short distances the young might be carried on the feet of birds or might be blown with the fallen leaves late in the season.

The blisters, often highly colored and usually arranged in rows parallel with the mid rib, one row on each side, are characteristic. This pest occurs in some of the fruit growing regions of Montana.

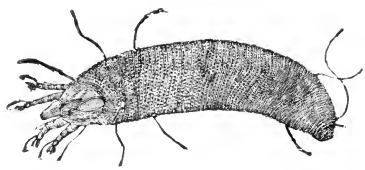


Fig. 23. **The Pear-leaf Blister-mite:** greatly enlarged. (Comstock, Manual for the Study of Insects, 1897.)

THE STRAWBERRY LEAF-ROLLER. 1.

The strawberry leaf-roller is a fairly well known pest in some parts of the United States. In the state of Washington it has been looked upon as their most serious insect enemy of strawberries. Though it has been in Montana for a number of years we have no record of great injury from it.. It occurs at Missoula, Helena, and Miles City. It receives its name from its habit of rolling and crumpling the leaves of its host-plants. The larva which is small

1. *Phoxopteris comptana* Frol.

and of a greenish color lives within the rolled or crumpled leaves feeding from the inside. When abundant, the larvae not only eat parts of the foliage but cause the remainder to turn brown. The larvae are very active and when taken into one's hand quickly wriggle out and drop to the ground.

There are two broods, one appearing in June and the other in August.

The larvae feed on the foliage of strawberry, raspberry, blackberry and various other plants.

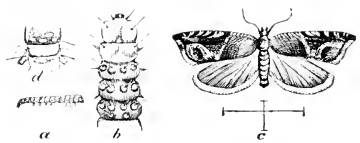


Fig. 24. **The Strawberry Leaf-roller:** a, larva, natural size; b, anterior end of larva, seen from above, enlarged; c, moth, enlarged; d, posterior end of larva, seen from above, enlarged. (First Rept. Insects of Mo., Riley, 1869.)

THE CHERRY FRUIT-FLY. 1.

The plum curculio is responsible for most "wormy" cherries but "cherry fruit-fly" may appear in the market fruits and if in the market is liable to escape to growing cherries. The cherry fruit fly as its name indicates is a fly and it is the larva or maggot that causes the damage. The work of the grub of the plum curculio is usually apparent from the exterior of the cherry, but in the case of this maggot the cherries may from the outside appear to be perfectly sound.

The cherry maggots are very light yellow in color and of the shape and size shown in the small black circle, above, in the accompanying figure.

The body of the fly is black and the head and legs are of a light yellow color. The wings are crossed by four blackish bands and have a blackish spot at the tip.

This insect is not very well known as a pest of cherries. It has been reported only from the eastern states. It is, however, one of

1. *Rhagoletis cingulata* Loew.

the insects that our Montana cherry growers should be on the lookout for.

The winter is passed by the immature insect in the ground. If this pest becomes established in Montana it will most likely be through the introduction of infested cherries. Wormy cherries rejected from those pitted for canning and thrown out on the refuse pile would furnish all the necessary conditions for the infection of any cherry trees in the vicinity that might be in bearing the next season.

Fig. 25. **The Cherry Fruit-fly:** Section of a cherry, enlarged to show the maggot and the nature of its work. The small figures above show the maggot and its parent, the fruit-fly, natural size. (Slingerland, Bull. 172, Cornell Univ. Exp. Sta., 1899.)

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